GEOLOGY, ENERGY, AND MINERAL (GEM) RESOURCE ASSESSMENT OF THE SPANISH POINT GEM RESOURCE AREA (GRA), WYOMING, INCLUDING THE PAINT ROCK WILDERNESS STUDY AREA (WY-010-239) THE MEDICINE LODGE WILDERNESS STUDY AREA (WY-010-240), THE ALKALI CREEK WILDERNESS STUDY AREA (WY-010-241), AND THE TRAPPER CREEK WSA (WY-010-242)

PHASE I

Contract No. YA-553-CT2-1055

Prepared for:

U.S. Bureau of Land Management

Prepared by:

Tetra Tech, Inc.
Pasadena, California

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EXECUTIVE SUMMARY

The U.S. Bureau of Land Management (BLM) has adopted a two-phase procedure for the integration of geologic, energy, and mineral (GEM) resources data for suitable/nonsuitable decisions concerning Wilderness Study Areas (WSAs). To facilitate this review, certain WSAs with similar geologic environments and mineral characteristics have been grouped together into larger GEM Resource Areas (GRAs). Using these guidelines, the Paint Rock, Medicine Lodge, Alkali Creek, and Trapper Creek WSAs were grouped together into the Spanish Point GRA. This report, which terminates the Phase I activities for the Spanish Point GRA, is an evaluation and interpretation of existing data concerning the GEM resource potential in the WSAs.

The Spanish Point GRA contains four WSAs: the Paint Rock WSA (WY-010-239); the Medicine Lodge WSA (WY-010-240); the Alkali Creek WSA (WY-010-241); and the Trapper Creek WSA (WY-010-242). All four of these WSAs are located in the BLM's Washakie Resource Area, Worland District, Wyoming.

The Spanish Point GRA has been identified as having potential occurrences of the following mineral resources: uranium, tar sands, and limestone. Areas of the WSAs are considered to have a moderate favorability for the potential occurrence of uranium (classified 3B and 3A); this classification is based on indirect and insufficient evidence (Damp and Jennings, 1982; Worchola and Stockton, 1982). The potential for uranium resources occurs in the Madison Limestone karst topography and the cross-bedded Tensleep Sandstone. The area is considered to have a moderate favorability for the potential occurrence of tar sands (classified 3B); this classification is based on indirect evidence (Wilson, 1955; Barrell, 1982A). The potential for tar sand resources occurs in the Goose Egg Formation and the Tensleep Sandstone. The area is considered to have a high favorability for the potential occurrence of limestone (classified 4C); this classification is based on direct but quantitatively minimal evidence (Vietti, 1977). The potential for limestone resources occurs in the Madison Limestone. Data supporting these conclusions come from the presence of these resources in similar geologic environments: for example,

the presence of uranium in uraniferous karst deposits in the Pryor Mountains, numerous limestone quarries in the Madison Limestone, and the existence of nearby tar occurrences in the Goose Egg Formation and Tensleep Sandstone.

Quantitatively minimal direct evidence exists to support a low favorability classification for the potential occurrence of other GEM resources in the study area (classified 2C). This classification is based on the geologic environment and the inferred geologic processes that have been identified within the WSAs.

Additional geologic investigations would help supplement the GEM resource evaluation of the Spanish Point GRA. Paleokarst features at the contact between the Madison Limestone and the Amsden Formation should be investigated and checked with a scintillometer for the presence of uranium in the WSAs. Outcrops of the Tensleep Sandstone should also be checked for uranium. A reconnaissance along the contact between the Goose Egg Formation and the Tensleep Sandstone should be made for evidence of asphalt or bitumens. Qualified BLM personnel should perform an additional review of the literature to obtain a more in-depth understanding of the geologic conditions in the Spanish Point GRA.

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GEM RESOURCE AREA
SPANISH POINT

1.0 INTRODUCTION

1.1 Purpose of Study

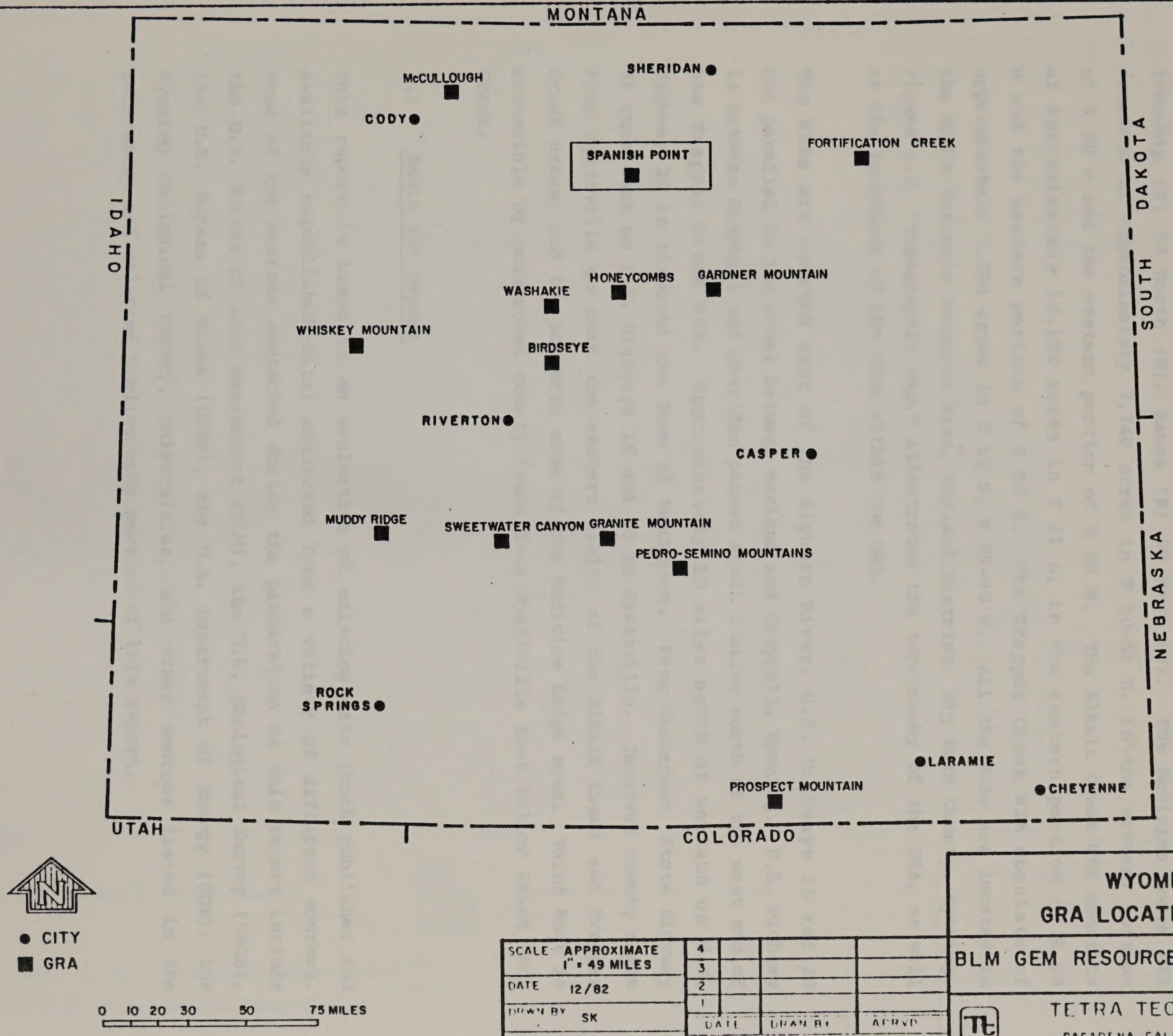
The U.S. Bureau of Land Management (BLM) has adopted a two-phase procedure for the integration of geologic, energy, and mineral (GEM) resources data for suitable/nonsuitable decisions concerning Wilderness Study Areas (WSAs). Phase I consists of a review and evaluation of existing data, resulting in an interpretation of the GEM resource potential in the WSA. Phase II is designed to generate only the additional data required to support the GEM resource recommendations presented during Phase I. To facilitate this review, certain WSAs with similar geologic environments and mineral characteristics have been grouped together into larger GEM Resource Areas (GRAs). Using these guidelines, the Paint Rock, Medicine Lodge, Alkali Creek, and Trapper Creek WSAs were grouped into the larger Spanish Point GRA. This report, which terminates the Phase I activities for the Spanish Point GRA, is an evaluation and interpretation of existing data concerning the GEM resource potential in the Paint Rock, Medicine Lodge, Alkali Creek and Trapper Creek WSAs.

The GEM resource evaluations for this study were performed by Tetra Tech, Inc. for the U.S. Bureau of Land Management, under Contract No. YA-553-CT2-1055. This study was completed in January, 1983.

1.2 Location and Access

This GEM report covers the area identified as the Spanish Point GEM Resource Area (GRA); the geographic location of the study area is shown in Figure 1.1, "GRA Location Map."

The Spanish Point GRA contains the following Wilderness Study Areas (WSAs): the Paint Rock WSA (WY-010-239); the Medicine Lodge WSA (WY-010-240); the Alkali Creek WSA (WY-010-241); and the Trapper Creek WSA (WY-010-242). These



WYOMING
GRA LOCATION MAP

BLM GEM RESOURCES ASSESSMENT

TETRA TECH INC
PASADENA, CALIFORNIA

1.1

SCALE	APPROXIMATE 1" = 49 MILES
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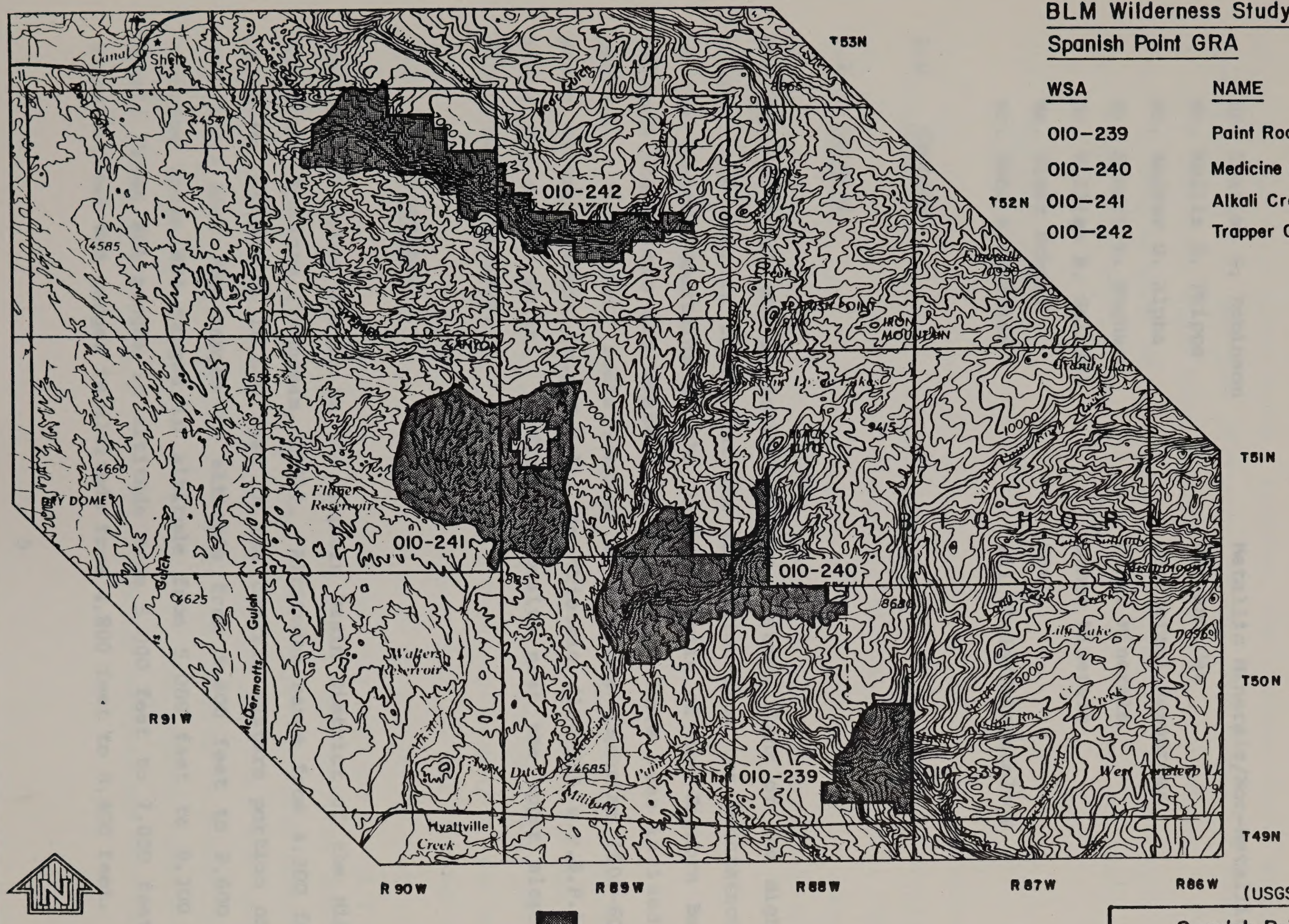
REVISIONS

WSAs are located along the west flank of the Bighorn Mountains. The Paint Rock WSA consists of approximately 2,700 acres in the southeast portion of Township (T) 50 North (N), Range (R) 88 West (W). The Medicine Lodge WSA consists of approximately 7,740 acres in T 50-51 N, in the western portion of R 88 W and the eastern portion of R 89 W. The Alkali Creek WSA consists of approximately 10,100 acres in T 51 N, in the eastern portion of R 89 W and the western portion of R 90 W. The Trapper Creek WSA consists of approximately 7,200 acres in T 52 N, R 89-90 W. All the WSAs are located in the BLM's Washakie Resource Area, Worland District, Big Horn County, Wyoming. Figure 1.2, "Topographic Map," illustrates the topography of the GRA, as well as the locations of the WSAs within the GRA.

The WSAs are located east of the Bighorn River; U.S. Highways 16 and 20 run parallel to the river between Worland and Greybull, Wyoming. U.S. Highway 14 between Greybull and Sheridan passes about 3 miles north of the west end of the Trapper Creek WSA. Approximately 20 miles north of Worland on U.S. Highway 20 is situated the Town of Manderson. From Manderson, State Highway 31 runs east on U.S. Highways 16 and 20 to Hyattville. Improved county roads from Hyattville go near the eastern limits of the Alkali Creek and Trapper Creek areas, and the southern edge of the Medicine Lodge area. Paint Rock is accessible by unimproved county roads from Hyattville that follow Paint Rock Creek.

1.3 Basis for Report

This report is based on an evaluation of existing data (both published and available unpublished data) collected from a variety of different sources. Some of the sources contacted during the preparation of this report include the U.S. Bureau of Land Management (BLM), the U.S. Geological Survey (USGS), the U.S. Bureau of Mines (USBM), the U.S. Department of Energy (DOE), the Wyoming Geological Survey, universities, and other sources listed in the references and selected bibliography section of this report.



BLM Wilderness Study Areas Included in the Spanish Point GRA

WSA	NAME	ACREAGE
010–239	Paint Rock	2,770
010–240	Medicine Lodge	7,740
010–241	Alkali Creek	10,100
010–242	Trapper Creek	7,200

(USGS, 1955; limited revision, 1962)

NOTE: Contours in 200ft. Intervals

▨ Approximate Boundary of Wilderness Study Area

5 4 3 2 1 0 3 6 Miles

5 4 3 2 1 0 5 10 Kilometers

SCALE	1"= 4 MILES 1:250,000	4			
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Spanish Point GRA, Wyoming

TOPOGRAPHIC MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC.
PASADENA, CALIFORNIA

FIGURE 1.2

The available literature was reviewed by a Project Team, assembled by the study contractor, comprised of authorities in the field of GEM resource evaluation. The members of the Project Team, and their associated technical disciplines, are identified below:

Mr. Charles S. Robinson	Metallic Minerals/Non-Metallic Minerals
Mr. Rollin E. Phipps	Oil and Gas
Mr. Andrew G. Alpha	Geothermal Resources
Mr. Stuart P. Hughes	Other Minerals
Mr. William A. Gallant	Other Minerals
Mr. Elmer Schell	Coal
Mr. John A. Hartley	Oil Shale/Paleontology

2.0 GEOLOGY

2.1 General

The Spanish Point GRA is located on the western flank of the Bighorn Mountains. The area is located at the transition from the mountainous terrain of the Bighorn Mountains to the valley terrain of the Bighorn Basin. The bedrock formations dip westward, and streams have been incised into the bedrock. Sedimentary rocks ranging in age from Cambrian (500-600 million years before present [m.y.B.P.]), to Triassic (180-225 m.y.B.P.) crop out along the canyon walls. Surficial deposits mask the upper slopes and the floors of the valleys.

2.2 Physiography

The Spanish Point GRA is in the Bighorn Basin District of the Middle Rocky Mountains Province (Fenneman, 1931). Altitudes range from 4,300 feet in the northwest corner to 10,600 feet in the central eastern portion of the GRA. The Paint Rock WSA ranges in altitude from 5,800 feet to 8,600 feet; the Medicine Lodge WSA ranges in altitude from 5,000 feet to 8,200 feet; the Alkali Creek WSA ranges in altitude from 5,000 feet to 7,000 feet; and the Trapper Creek WSA ranges in altitude from 4,800 feet to 8,400 feet.

The Paint Rock WSA is bisected by Paint Rock Creek, which flows westerly into the Bighorn River; the Medicine Lodge WSA straddles two major forks of Medicine Lodge Creek, both of which flow into Paint Rock Creek; Alkali Creek penetrates the Alkali Creek WSA, but this creek is not as large as Paint Rock Creek or Medicine Lodge Creek; finally, the Trapper Creek WSA generally borders and follows the path of Trapper Creek. Dip slopes are deeply incised by major drainages which have numerous small tributary streams. The climate along the western flank of the Bighorn Mountains below 8,000 feet is semiarid. Below 8,000 feet, precipitation is approximately 9 inches per year.

2.3 Geologic Units

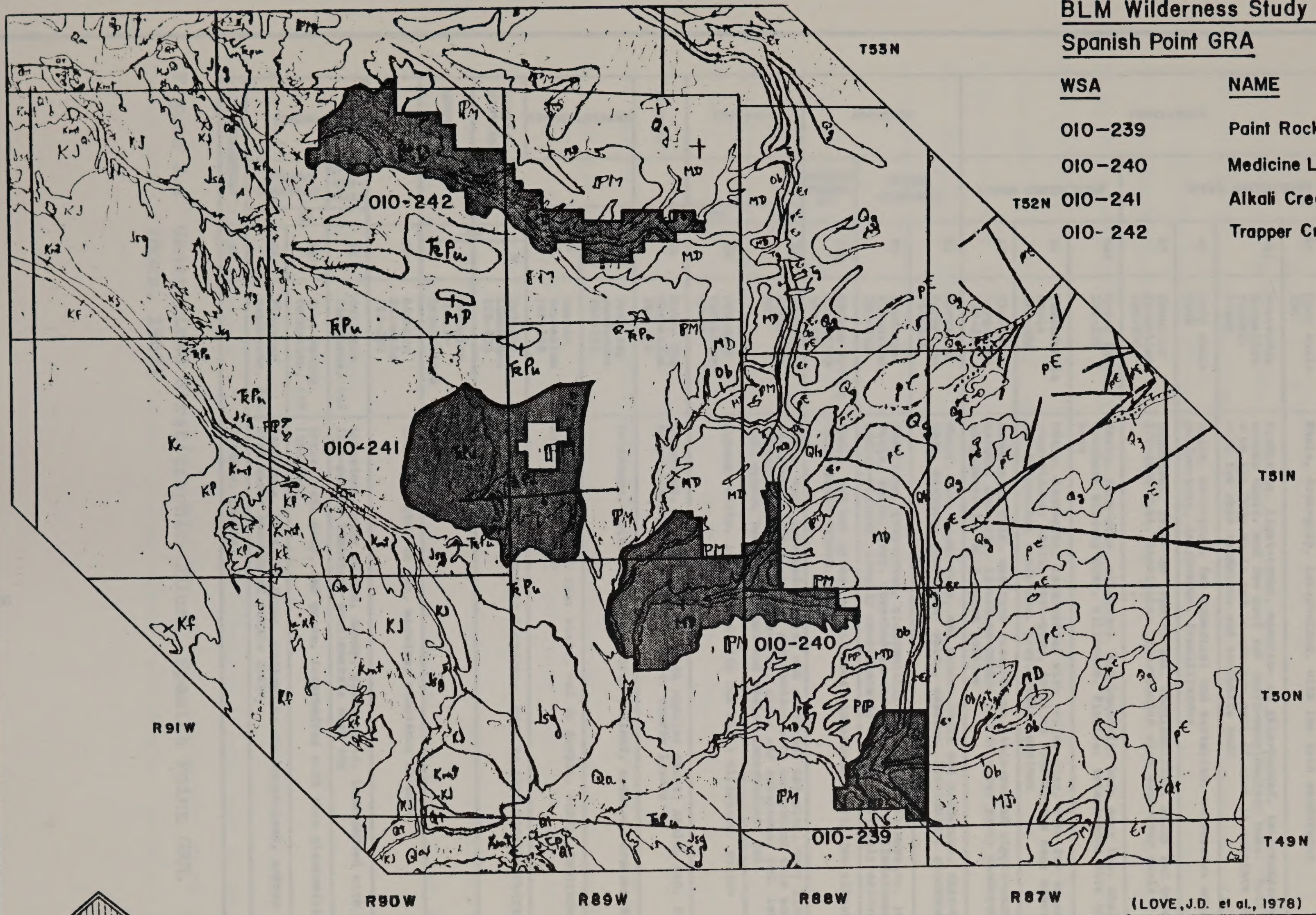
The rock units which occur in the Spanish Point area are sedimentary rocks of Paleozoic age (225 m.y.B.P.). Figure 2.1, "Geologic Map," delineates the geologic formations that occur throughout the GRA. Figure 2.2, "Generalized Stratigraphic Column," is a generalized stratigraphic column that gives a brief description of all the stratigraphic units that underlie the Spanish Point GRA.

2.3.1 Bedrock Units

The Precambrian (> 600 m.y.B.P.) rocks which form the core of the Bighorn Mountains do not crop out in the study areas, but underlie the rocks that do. Precambrian rocks consist of a variety of granitic rocks and gneisses. Overlying the Precambrian rocks are the Flathead Sandstone, the Gros Ventre Formation, and the Gallatin Limestone, all of Cambrian age (500-600 m.y.B.P.). The Flathead Sandstone consists of medium to coarse-grained sand at the base. The Gros Ventre Formation is predominately red, gray, and green shale, with thin interbedded sandstone and limestone. The Gallatin Limestone is a glauconitic limestone with thin interbedded shale and sandy limestone. The Bighorn Dolomite of Upper Ordovician (400-500 m.y.B.P.) age unconformably overlies the Cambrian Formation. The Bighorn Dolomite is primarily a massive dolomite with thin sandstone at the base. The Madison Limestone of Mississippian (300-350 m.y.B.P.) age unconformably overlies the Bighorn Dolomite.

BLM Wilderness Study Areas Included in the Spanish Point GRA

WSA	NAME	ACREAGE
010-239	Paint Rock	2,770
010-240	Medicine Lodge	7,740
010-241	Alkali Creek	10,100
010-242	Trapper Creek	7,200



(LOVE, J.D. et al., 1978)

▨ Approximate Boundary of Wilderness Study Area

5 4 3 2 1 0 3 6 Miles

5 4 3 2 1 0 5 10 Kilometers

SCALE	1" = 4 MILES 1 : 250,000	4			
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DATE	12/82	2			
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Spanish Point GRA, Wyoming

GEOLOGIC MAP

BLM GEM RESOURCES ASSESSMENT

REGION 6 WYOMING and MONTANA

TETRA TECH INC.

PASADENA, CALIFORNIA

FIGURE 2.1

SYSTEM	SERIES		SYMBOL	FORMATION, THICKNESS, FT	GENERAL LITHOLOGIC DESCRIPTION
QUAT-ERNARY			Qg Qls Qa Qt	Quaternary Undif-ferentiated	
CRETACEOUS	UPPER CRETACEOUS		Kmt	Meeteetse formation, 410	Shale and sandstone, thin-bedded, interbedded with coal and bentonite; sandstone, gray, fine-grained, poorly consolidated, interbedded with shale and bentonite
			Kc	Cody shale 250	Shale, drak-gray, interbedded, with few thin sandstones
			Kml	Mesaverde formation (lower) 0-300	Sandstone, light-brown, massive- to thin-bedded, interbedded with gray and carbonaceous shale, and few coal and chert-conglomerate beds. This unit intertongues with the Cody shale and in eastern part of area it consists of dark-gray shale with few thin sandstone and bentonite beds
			Kc	Cody shale 2800	Shale, dark-gray, few spherical and septatian, calcareous concretions; shale, yellow-gray, calcareous, fossiliferous
			Kf	Frontier formation 430-570	Sandstone, gray- to light-brown, conglomeratic, black and brown chert pebbles 1/2-inch size, lenticular, interbedded with dark-gray shale
	LOWER CRETACEOUS		Kmr	Mowry shale 270-290	Shale, dark-gray, siliceous, two bentonite beds near top; shale, drak-gray, weathers silvery gray, siliceous, fissile, interbedded with thin white clay beds
			Kt	Thermopolis shale 340-380	Shale, dark-gray, interbedded with yellow clay, with few zones of ironstone concretions; shale, dark-gray, dahllite concretions near base; shale, dark-gray, and bentonite; sandstone, gray, medium grained
			KJ	Cloverly formation 190-230	Sandstone, gray, weathers rusty-brown, thin-bedded ripple-marked; shale red, maroon, and gray, limestone-cobble bed in upper part; sandstone, gray crossbedded, conglomeratic, with chert pebbles
JURASSIC	UPPER JURASSIC		KJ	Morrison formation 190-250	Shale, red, pink, gray, and green; shale and sandstone, thin-bedded; some sandstone beds, massive; sandstone, white, massive, lenticular, crossbedded
			KJ	Sundance formation 200-330	Sandstone, gray-green, glauconitic, thin-bedded to massive, interbedded with green shale; shale, gray, interbedded with thin coquinoid limestones; sandstone, tan, medium-grained, locally conglomeratic at base, slightly calcareous
	MIDDLE JURAS-SIC		Jsg	Gypsum Spring formation 80-140	Shale, red and green, gypsiferous, interbedded with few siltstone and gray limestones; gypsum, white
TRIASSIC		T̄RPu	T̄Rc	Chugwater formation 960	Shale, red, interbedded with red siltstone and pink, very fine-grained sandstone; sandstone, reddish-brown; interbedded with occasional thin beds of red shale and siltstone; limestone, blue-gray; shale and siltstone, red, interbedded with few thin gypsum beds; siltstone and shale, interbedded, red
			T̄Rd	Dinwoody formation 40-60	Gypsum, white, interbedded with red shale siltstone, yellow
PERMIAN			Pu	Goose Egg formation 200-280	Limestone, gray, dolomitic, with nodular chert; shale, red, few thin limestone beds; limestone, gray, dolomitic, cherty layers
PENNSYLVANIAN		IPM	IP	Tensleep sandstone 280-390	Sandstone, white to bluff, medium-grained, massive, crossbedded
			IP	Amsden formation 190-290	Dolomite, white to tan; shale, red to purple, sandy; sandstone, gray to brown, locally quartzitic
MISSIS-SIPPIAN		MD	M	Madison Limestone 325-425	Limestone and dolomitic limestone, gray to tan, locally cherty
DEVONIAN				Devonian Undif-ferentiated	
ORDOVICIAN			Ob	Bighorn dolomite 150-200	Dolomite, gray to tan, massive; sandstone at base
CAMBRIAN	UPPER CAM-BRIAN	Єr	Єg	Gallatin limestone, 440	Limestone, gray to tan, sandy, glauconitic, interbedded with gray to green shale; flat-pebble limestone conglomerate near top
	MIDDLE CAMBRIAN		Єgv	Gros Ventre formation, 470	Shale, red, gray, and green, interbedded with thin glauconitic sandstone and limestone
			Єf	Flathead sandstone, 200	Sandstone, white to brown, medium- to coarse-grained, arkose at base, interbedded with minor amounts of purple shale
PRECAMBRIAN			pЄ		Granite, gneiss

Figure 2.2 Generalized Stratigraphic Column, Spanish Point GRA. (Horn, 1963)

The Madison Limestone consists of cherty limestone and dolomite. The Amsden Formation of Pennsylvanian (270-300 m.y.B.P.) age unconformably overlies the Madison Limestone. The Amsden Formation includes the Darwin Sandstone Member at the base, overlain by red to purple sandy shale, with light gray sandy dolomite at the top. Conformable with the Amsden Formation, and also of Pennsylvanian age, is the overlying Tensleep Sandstone. The Tensleep Sandstone consists of medium-grained, massive, and crossbedded sandstone. The Goose Egg Formation of Permian (225-270 m.y.B.P.) age unconformably overlies the Tensleep Sandstone. The Goose Egg Formation consists of interbedded gray limestone and dolomite and reddish-brown shale. It is gradational with the overlying Dinwoody Formation of Triassic age; the Dinwoody Formation consists of interbedded shale and gypsum. The youngest bedrock formation exposed in the Spanish Point area is the Chugwater Formation of Triassic age. The Chugwater Formation consists of reddish interbedded shale, siltstone, sandstone, limestone and gypsum.

2.3.2 Surficial Deposits

The surficial deposits within the GRA include colluvium and alluvium. Colluvium occurs on the gentler slopes and is derived from the weathering of bedrock. Along the canyons at the base of the cliffs are local accumulations of talus, a type of colluvium, derived from weathering of the cliffs. Alluvium is found at the bottom of the stream valleys; the composition of the alluvium reflects the type of bedrock upstream and adjacent to the streams. The Paint Rock WSA has along its eastern edge an area designated as "Tertiary gravel and landslides" (Vietti, 1977). This is probably an area of Tertiary terrace gravels that have failed along the valley of Paint Rock Creek.

2.4 Structural Geology

The bedrock units are on the west flank of the Bighorn Mountains. In general, the formations in the WSAs strike northwest and dip 5° to 10° southwest (Vietti, 1977). A major fault passes through the lower part of the Alkali Creek WSA (Vietti, 1977; Love, Christiansen, and Earle, 1978). The fault is a

high-angle normal fault, aligned east-west, with the north side upthrown. Structures in the nearby Precambrian rocks (faults) may be reflected in the overlying sedimentary bedrock.

2.5 Engineering Geology

The bedrock units are generally massive with high strength; because of this, major engineering problems could occur while making side hill cuts in the massive units. The carbonate units, particularly the Madison Limestone, are noted for the development of karst topography. Therefore, any construction on the Madison Limestone must consider the possibility of caves and sink holes. Local rockfalls, and possibly talus slides, could occur below the higher cliffs. A major area of Tertiary gravels and landslides has been mapped along the eastern margin of the Paint Rock area (Vietti, 1977).

2.6 Paleontologic Resources

The Paleozoic marine units have the potential to contain some invertebrate fossils, but none have been reported from the area. There are no Mesozoic (70-225 m.y.B.P.) or Cenozoic (< 70 m.y.B.P.) non-marine deposits in the areas, so the presence of vertebrate fossils is unlikely. Recent vertebrate fossils have been found in caves developed in the Madison Limestone along the western flank of the Bighorn Mountains north of the GRA. The potential occurrence of paleontologic resources in the WSAs in those areas where the Madison Limestone crops out should be considered high because of the occurrence of paleontologic resources in similar geologic environments in other areas of the Bighorn Basin.

2.7 Historical Geology

The geologic history of the Spanish Point GRA is similar to that of the Bighorn Mountains. The basement Precambrian rocks in the core of the Bighorn Mountains, which are exposed to the east of the study area, consist of metaigneous and metasedimentary rocks, the history of which is not well understood. At the end of Precambrian time, and throughout the Paleozoic era,

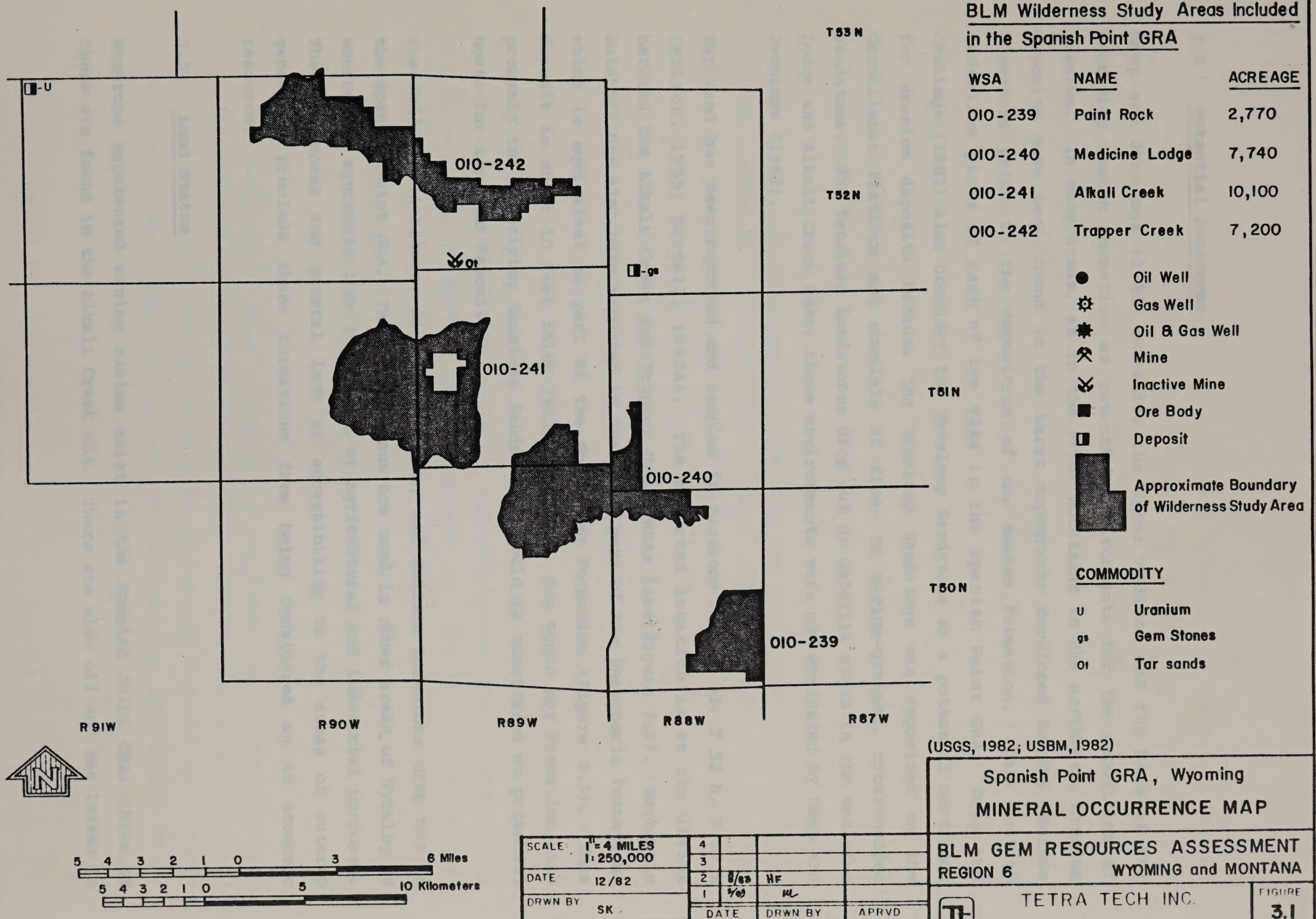
there were repeated advances and retreats of the sea. Marine deposits of sandstone, shale, limestone, and dolomite were formed. At the end of the Paleozoic era, marine, marginal marine (evaporites), and terrestrial red-bed deposits were formed as the seas fluctuated back and forth over the area. Marine conditions returned in Jurassic (135-180 m.y.B.P.) time, only to retreat by the end of the Jurassic period. A major marine invasion occurred in early Cretaceous (70-135 m.y.B.P.) time and continued until the Laramide orogeny, which began approximately at the end of the Cretaceous period. Only the lowermost Mesozoic/Triassic formations are exposed in the Spanish Point GRA. All of the younger formations have been removed by erosion. The Tertiary (2-70 m.y.B.P.) period was a period of repeated uplift (Bighorn Mountains), accompanied by folding, thrusting, and high-angle faulting, together with the deposition of thick terrestrial sediments in the inter-mountain basins (i.e. Bighorn Basin). Volcanism was active in the mid to late Tertiary time to the northwest, and thick volcanic deposits accumulated locally; volcanic ash deposits are widely spread throughout the area. This volcanic ash may have been a source rock of uranium; this uranium may have migrated by groundwater into favorable rock units in the area. The Quaternary (2-3 m.y.B.P.) period is noted for both the widespread glaciation in the mountains to the east, and the accompanying deposition of glacial outwash along the flanks of the mountains.

3.0 ENERGY AND MINERAL RESOURCES

3.1 General

The Spanish Point area has an abundance of limestone potentially suitable for the manufacture of cement or industrial and agricultural lime; however, the sources of this resource are far from potential markets. The area has the potential for occurrences of uranium and tar sand.

Figure 3.1, "Mineral Occurrence Map," illustrates the presence of any known past and present mine locations, or occurrences of mineral deposits and GEM resources within the GRA. The sources of information for this figure are the USGS' Computerized Resource Information Bank (CRIB), and the USBM's Minerals Availability System (MILS).



BLM Wilderness Study Areas Included in the Spanish Point GRA

WSA	NAME	ACREAGE
010-239	Paint Rock	2,770
010-240	Medicine Lodge	7,740
010-241	Alkali Creek	10,100
010-242	Trapper Creek	7,200

(USGS, 1982; USBM, 1982)

Spanish Point GRA, Wyoming

MINERAL OCCURRENCE MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC.
PASADENA, CALIFORNIA

FIGURE 3.1

SCALE: 1"=4 MILES 1:250,000	4			
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3.2 Potential Resources

Damp and Jennings (1982) consider the Upper Madison and the base of the overlying Amsden Formation as potential environments for the deposition of uranium. In many areas, as in the Pryor Mountains to the northwest, uranium deposits have been found in the karst topography developed on the Madison Limestone prior to the deposition of the Amsden Formation. This contact underlies parts of each of the WSAs in the Spanish Point GRA. Damp and Jennings (1982) also consider the Tensleep Sandstone as a potential host rock for uranium deposits because the Tensleep Sandstone was deposited on the Cordilleran Platform and consists of fine- to medium-grained, cross-bedded sandstone. The Tensleep Sandstones crop out or underlie areas in the Medicine Lodge and Alkali Creek WSAs; these environments were not evaluated by Damp and Jennings (1982).

Tar sand has been reported and sampled in Sections 32 and 33, T 52 N, R 89 W (Wilson, 1955; Barrell, 1982A). The reported location is on the divide between the Alkali Creek and Trapper Creek WSAs (see Figure 3.1). Asphaltic material has also been reported in the basal part of the Phosphoria Formation, which is equivalent to part of the Goose Egg Formation (Figure 2.2). This deposit is about 10 feet thick (Wilson, 1955). The Goose Egg Formation, and probably the underlying Tensleep Sandstone, should be considered as potential hosts for tar sand deposits.

The Gallatin Limestone, Bighorn Dolomite, and Madison Limestone crop out in the Spanish Point GRA. These formations are used in other areas of Wyoming as sources of aggregate lime for cement or agricultural and industrial purposes. The remoteness and general lack of accessibility to the areas of outcrop generally preclude these formations from being considered as an economic resource.

3.3 Land Status

Numerous unpatented mining claims exist in the Spanish Point GRA; three of these are found in the Alkali Creek WSA. There are also oil and gas leases in

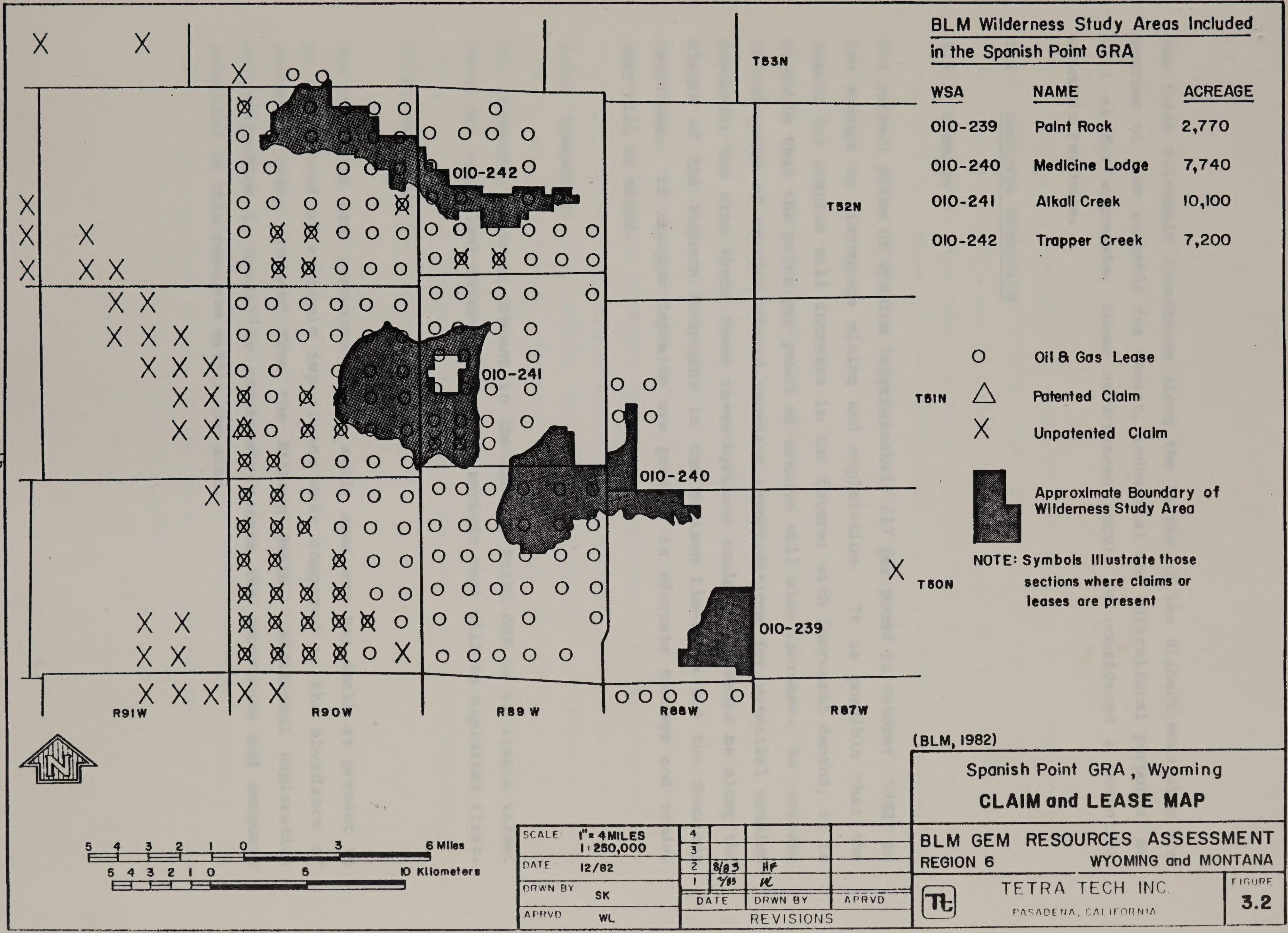
the GRA and many of these are in the Medicine Lodge, Alkali Creek, and Trapper Creek WSAs. The Paint Rock WSA is the only WSA in the Spanish Point GRA with neither mining claims or oil and gas leases. Figure 3.2, "Claim and Lease Map," illustrates the locations of any oil and gas leases, patented claims, or unpatented claims in the Spanish Point GRA. The oil and gas leases probably reflect interest in areas potentially valuable for tar sand. As shown, the region does not have any patented claims.

3.4 Deposit Types

The potential mineral deposits in the Spanish Point GRA are uranium, tar sand, and limestone.

Uranium in the Little Mountains occurs in the upper part of the Madison Limestone (McEldowny, Abshiev, and Lootens, 1977; Worchola and Stockton, 1982). The Madison Limestone, after the uplift of the Bighorn and Pryor Mountains, was subjected to solution along joints and faults as erosion lowered the regional groundwater table. The solution enlarged the joints and faults forming caves, some of which collapsed. Material eroded from the overlying Amsden Formation and water from surface sources were deposited in the open spaces. The top of the Madison Limestone, where exposed today, forms karst topography. Uranium bearing waters entered the system of caves and solution channels probably during Plio-Pleistocene time. Organic material, or possibly hydrogen sulfide, reduced the uranium in solution, and uranium was precipitated in the cavity fillings. The same conditions could exist on the west flank of the Bighorn Mountains. This possibility has not been investigated in detail in the Spanish Point GRA (Damp and Jennings, 1982).

The occurrence of tar sand in the Goose Egg Formation, between Trapper and Alkali Creeks, is probably what prompted the U.S. Geological Survey to classify 4 townships in the region as areas of possible asphalts and bitumens (USGS, 1964). There are numerous oil and gas fields in the Bighorn Basin; because of this, the potential exists for the migration of petroleum through porous units to the outcrop.



BLM Wilderness Study Areas Included in the Spanish Point GRA

WSA	NAME	ACREAGE
010-239	Paint Rock	2,770
010-240	Medicine Lodge	7,740
010-241	Alkali Creek	10,100
010-242	Trapper Creek	7,200

○ Oil & Gas Lease

△ Patented Claim

X Unpatented Claim

▨ Approximate Boundary of Wilderness Study Area

NOTE: Symbols illustrate those sections where claims or leases are present

(BLM, 1982)

Spanish Point GRA, Wyoming

CLAIM and LEASE MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC.
PASADENA, CALIFORNIA

FIGURE 3.2

SCALE: 1" = 4 MILES
1:250,000
DATE: 12/82
DRWN BY: SK
APRVD: WL

	DATE	DRWN BY	APRVD
4			
3			
2	8/83	HF	
1	7/83	WL	

REVISIONS

The thick Paleozoic limestones along the flanks of the Bighorn Mountains are sources of lime suitable for cement, industrial and agricultural purposes, as well as for aggregate; these occurrences should be considered a potential economic resource.

3.5 Resource Economics

3.5.1 Uranium

The current price of uranium (approximately $17 per pound in October, 1982) is low enough to discourage mining and exploration. It is possible that the demand for uranium will increase in the future; with increased demand, it is probable that the price per pound of uranium will also increase. An increase in the price of uranium should increase investigations for potential uranium deposits; one area where these investigations could occur would be along the flanks of the Bighorn Mountains in the Madison Limestone and the Tensleep Sandstone. If uranium deposits are present in adequate tonnage and grade, they will be mined.

3.5.2 Limestone

The limestone resource present in the Spanish Point GRA is of little value. There are equivalent outcrops nearer to markets that will be exploited first.

3.5.3 Tar Sands

The known tar sand resources in the study area are too small at present to be considered of economic importance when compared to the abundance of petroleum being produced from the Bighorn Basin. Additional exploration and evaluation is needed to accurately assess the occurrence and economic potential of this resource within the area.

4.0 LAND CLASSIFICATION FOR GEM RESOURCE POTENTIAL

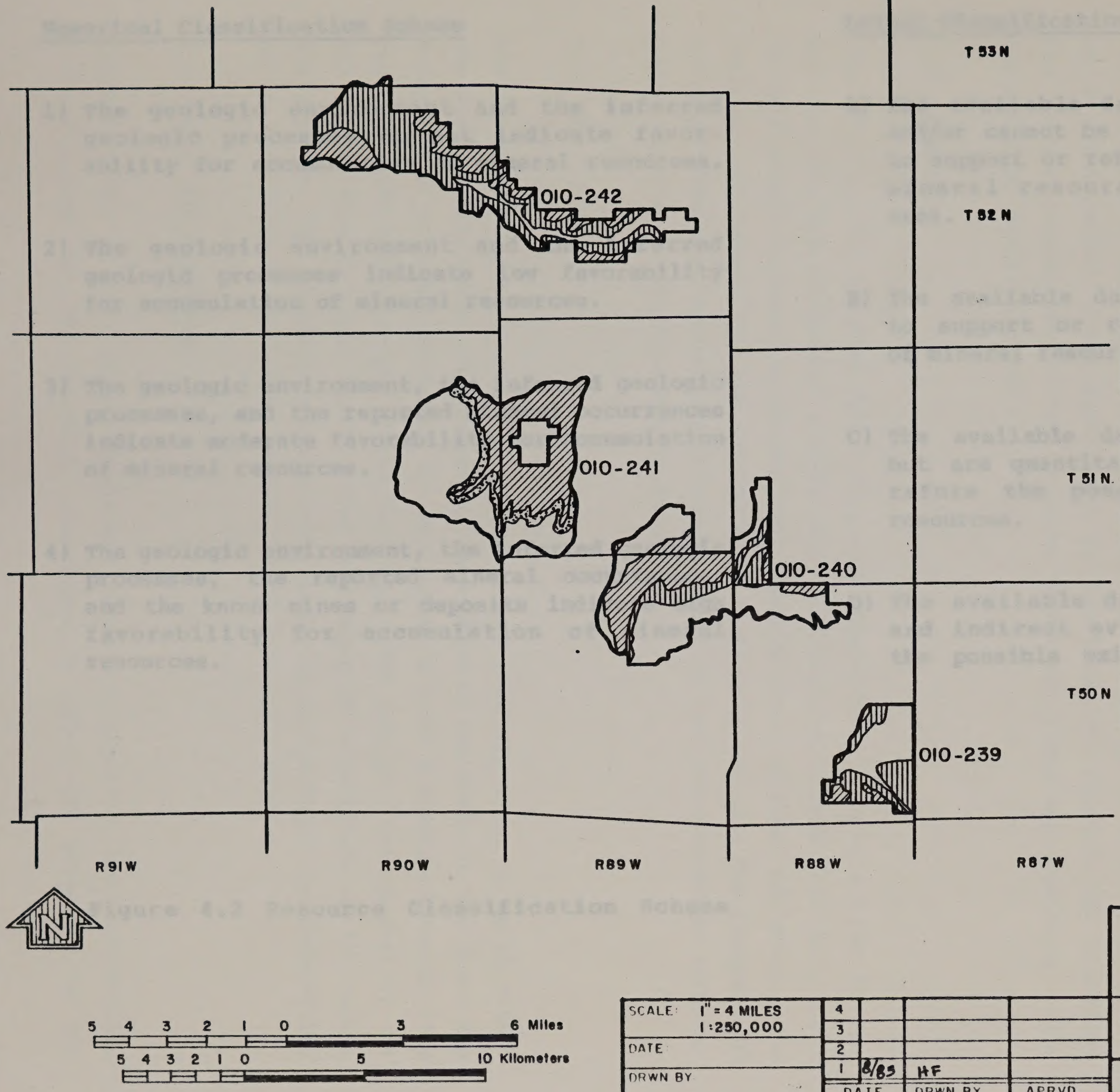
4.1 General

The Spanish Point GEM Resource Area (GRA) includes the Paint Rock, Medicine Lodge, Alkali Creek, and Trapper Creek WSAs. All of these areas are in a similar physiographic and geologic environment on the west flank of the Bighorn Mountains, and have the same potential for mineral resources. The potential mineral resources identified in the area are uranium, limestone, and tar sands. The potential occurrence of other GEM resources in the study area is considered low.

In order to better evaluate the occurrence or potential occurrence of resources in the GRA, a 2-part resource classification scheme has been adopted as requested by contract. Each resource or potential resource within the GRA will receive an alpha-numeric designation. The number designation will range from 1 to 4, and will indicate the favorability of the geologic environment, geologic processes, and mineral occurrences for the presence of a particular resource or group of resources. The letter designation will range from A to D, and will indicate the level of confidence to be associated with the numerical designation. Figure 4.1, "Land Classification Map," illustrates the areas of potential GEM resources with their assigned classifications for the WSAs within the Spanish Point GRA. Figure 4.2, "Resource Classification Scheme," provides a detailed description of the number and letter designations used in the resource classification scheme.

4.2 Uranium

The WSAs within the Spanish Point GRA are considered to have a moderate favorability for the potential occurrence of uranium (classified 3B and 3A); these classifications are based on indirect or insufficient evidence. The potential occurrence of uranium in the region is classified as 3B in the Tensleep Sandstone and 3A in the Madison Limestone.



BLM Wilderness Study Areas Included in the Spanish Point GRA

WSA	NAME	ACREAGE
010-239	Paint Rock	2,770
010-240	Medicine Lodge	7,740
010-241	Alkali Creek	10,100
010-242	Trapper Creek	7,200

SYMBOL	GEM RESOURCE	CLASSIFICATION
▨	Uranium Limestone Other GEM Resources	3B 4C 2C
▥	Uranium Limestone Other GEM Resources	3A 4C 2C
▒	Tar Sand Other GEM Resources	3B 2C
☐	Other GEM Resources	2C
☐	Approximate Boundary of Wilderness Study Area	

Spanish Point GRA, Wyoming

LAND CLASSIFICATION MAP

BLM GEM RESOURCES ASSESSMENT
REGION 6 WYOMING and MONTANA

TETRA TECH INC.
PASADENA, CALIFORNIA

FIGURE 4.1

SCALE: 1" = 4 MILES
1:250,000
DATE:
DRWN BY:
APRVD:

	DATE	DRWN BY	APRVD
4			
3			
2			
1	8/85	HF	

REVISIONS

Numerical Classification Scheme

1) The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.

2) The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.

3) The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.

4) The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

Letter Classification Scheme (Level of Confidence)

A) The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B) The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C) The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D) The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Figure 4.2 Resource Classification Scheme

In the areas underlain by the Madison Limestone and the Tensleep Sandstone, the geologic environment is suitable for the accumulation of uranium. Geologic processes have occurred in the study area which could give rise to a source of uranium, and transport the uranium to an environment suitable for its deposition (i.e, karst topography in the Madison Limestone, or cross-bedded sandstones with facies changes in the Tensleep Sandstone). The specific geologic environments in the Spanish Point area have not been studied in enough detail to support or refute the possible existence of uranium in the Madison Limestone, and only indirect evidence (i.e. the existence of a cross-bedded clean sandstone) is available to support the potential for uranium deposition in the Tensleep Sandstone (Damp and Jennings, 1982; Worchola and Stockton, 1982).

4.3 Limestone

The WSAs in the Spanish Point GRA are considered to have a high favorability for the potential occurrence of limestone (classified 4C); this classification is based on direct, but quantitatively minimal evidence. The geologic environment and the available geologic data indicate the presence of suitable limestone material, but this material is not now economical to mine, nor will it be in the foreseeable future.

4.4 Tar Sands

Tar sands are known to exist in the area, but none are known to exist within the Spanish Point GRA. The potential occurrence of tar sands in the Goose Egg Formation or Tensleep Sandstone is considered to have a moderate favorability based on indirect evidence (classified 3B). The geologic environment of the GRA is the same as other nearby areas with reported occurrences of tar sands; furthermore, the available data provide indirect evidence of the possibility of the existence of tar sands (Wilson, 1955; Barrell, 1982A).

4.5 Other GEM Resources

Quantitatively minimal direct evidence exists to support a low favorability classification for the potential occurrence of other GEM resources in the

WSAs (classified 2C). This classification is based on the geologic environment and inferred geologic processes that have been identified within the WSAs.

5.0 RECOMMENDATIONS FOR FURTHER WORK

5.1 Work Recommended to Complete Data Base

A number of investigations could be implemented to generate additional data to supplement the conclusions of this Phase I report for the Spanish Point GRA. The potential occurrence of uranium at the top of the Madison Limestone and in the Tensleep Sandstone should be investigated; also, the occurrence of tar sands should be determined. To check the potential for uranium, the contact between the Madison Limestone and the Amsden Formation in the WSAs within the GRA should be mapped and the occurrence of paleokarst features shown. The paleokarst features should be checked with a scintillometer. The Tensleep Sandstone within the WSAs should be mapped and the outcrops checked with a scintillometer. Anomalous outcrops should be sampled, and the samples submitted for uranium analyses. Tar sands are restricted to the lower part of the Goose Egg Formation or the Tensleep Sandstone. A reconnaissance should be made around the outcrops of these formations for evidence of asphalt or bitumens.

6.0 REFERENCES AND SELECTED BIBLIOGRAPHY

1. Atomic Energy Commission, Division of Raw Materials. 1950-58. Preliminary Reconnaissance Reports on Reported Occurrences of Uranium Deposits, Wyoming, Big Horn County. U.S. Geological Survey.

2. Barlow and Haun, Inc. 1977. Structure Contour Map of Southeast 1/4 Bighorn Basin, Wyoming. The Petroleum Ownership Company.

3. Barrell, S. n.d.A. Existing Geochemical Stream Sediment Data Corresponds to Data Points on Stream Sediment Overlay.

4. Barrell, S. n.d.B. Washakie Resource Area Mineral Maps (10). U.S. Bureau of Land Management.

5. Barrell, S. 1981. Mineral in Character Evaluation: Bureau-Initiated Proposal to Withdraw Paint Rock Canyon from the United States Mining Laws. U.S. Bureau of Land Management.

6. Barrell, S. 1982A. Validity Examination of the Mid-Day Silica Sands, and Black Ore Placer Mining Claims. U.S. Bureau of Land Management.

7. Barrell, S. 1982B. Wyoming Bureau of Land Management, Minerals Reports Atlas IV Validity Examinations. U.S. Bureau of Land Management, Worland District Office.

8. Damp, J.N. and Jennings, M.D. 1982. National Uranium Resource Evaluation, Sheridan Quadrangle, Wyoming and Montana. Grand Junction, Colorado: Bendix Field Engineering Corporation for the U.S. Department of Energy, Report PGJ/F-127 (82).

9. Fenneman, N.M. 1931. Physiography of the Western United States. New York: McGraw-Hill Book Company.

10. Garrand, L.J.; Kopp, R.S.; and Cohenour, R.E. 1982. National Uranium Resources Evaluation, Cody Quadrangle, Wyoming. Grand Junction, Colorado: Bendix Field Engineering Corporation for the U.S. Department of Energy, Open File Report PGJ/P-043 (82).

11. Heroy, W.B., Jr. 1941. Geology of the Shell Canyon Area, Bighorn Mountains, Wyoming. Dissertation Abstracts International.

12. Horn, G.H. 1963. Geology of the East Thermopolis Area, Hot Springs and Washakie Counties, Wyoming. U.S. Geological Survey, Oil and Gas Investigations Map OM-213.

13. Kiilsgaard, T.H.; Ericksen, G.E.; Patten, L.L.; and Bieniewski, C.L. 1972. Mineral Resources of the Cloud Peak Primitive Area, Wyoming. U.S. Geological Survey Bulletin 1371C.

14. Love, J.D.; Christiansen A.C.; and Earle, J.L. 1978. Preliminary Geologic Map of the Sheridan 1° x 2° Quadrangle, Northern Wyoming. U.S. Geological Survey Open File Report 78-456.

15. McEldowny, R.C.; Abshiev, J.F.; and Lootens, D.J. 1977. Geology of the Uranium Deposits in the Madison Limestone, Little Mountain Area, Big Horn County, Wyoming. In Exploration Frontiers of the Central and Southern Rockies, ed. H.K. Veal. Rocky Mountain Association Geology 1977 Symposium.

16. Notley, D.F. 1947. Geology of the West End of the Tensleep Fault, Wyoming. Unpublished Thesis.

17. Segerstrom, K.; Weisner, R.C.; and Jackson, D.B. 1976. Mineral Resources of Area Adjacent to the Cloud Peak Primitive Area, Wyoming. U.S. Geological Survey Bulletin 1391-D.

18. Trotter, J.F. 1954. Geology of the Nowood Creek-Tensleep Area, Washakie County, Wyoming. Unpublished Thesis.

19. Ugolini, F. 1982. National Park Service. Personal Communication. List of National Registry of National Landmarks, (List of Geologic Features Designated as National Landmarks); and List of Recommended Geologic Features in Natural History Theme Studies for Montana (updated December 1981) and Wyoming (updated March 1981).

20. U.S. Bureau of Land Management. 1982. Master Title Plats. Plats for the study area were supplied to Tetra Tech by the BLM in August, 1982.

21. U.S. Bureau of Mines. 1982. Minerals Availability System (MILS) Deposit Listing. Listings for the study areas were supplied to Tetra Tech by the USBM in August, 1982.

22. U.S. Department of the Interior, Minerals Management Service. 1979. Bentonite in the Worland District. U.S. Bureau of Land Management.

23. U.S. Geological Survey. 1937. Geological Map of Big Horn County, Wyoming. Geological Survey of Wyoming.

24. U.S. Geological Survey. 1955; limited revision, 1962. Sheridan 1° x 2° Topographic Quadrangle, scale 1:250,000, contour interval 200 feet, Sheridan, Wyoming; Montana, NL 13-10.

25. U.S. Geological Survey. 1964. Mineral Resource Report, Bighorn Basin, Wyoming and Montana. U.S. Geological Survey unpublished report.

26. U.S. Geological Survey. 1982. Computerized Resources Information Bank (CRIB) Mineral Resources Files. Files for the study areas were supplied to Tetra Tech by the USGS in August, 1982.

27. Vietti, B.T. 1977. The Geohydrology of the Black Butte and Canyon Creek Areas, Bighorn Mountains, Wyoming. Unpublished Thesis.

28. Williams, L.O., Jr. 1962. Geology of the Crazy Woman Canyon, Powder River Pass, Tensleep Canyon Area, Bighorn Mountains, Wyoming. Dissertation Abstracts International.

29. Wilson, W.H. 1955. A Bituminous Sandstone Deposit, Big Horn County. Wyoming Geological Survey.

30. Worchola, J.D. and Stockton, T.J. 1982. National Uranium Resource Evaluation of the Billings Quadrangle, Montana. U.S. Department of Energy, Open File Report PGJ/F-015 (82).

31. Wyoming Geological Survey. 1937. Geologic Map of Big Horn County, Wyoming.